What is claimed is:

1. A method of sensing pressure in which applied pressure causes a change in the magnetization vectors of ferromagnetic layers within the device and a corresponding change in resistance that can be sensed upon application of an externally supplied voltage comprising the steps of:

providing a sensing device with a sensor including plurality of layers, the plurality of layers comprising a non magnetic insulating barrier layer disposed between at least two ferromagnetic layers which are in an initial state such that their magnetization vectors are stable with respect to each other, and at least one of the ferromagnetic layers having non-zero magnetostriction; and

sensing the resistance in the plurality of layers upon application of pressure while the externally supplied voltage is applied, the applied pressure causing the magnetization vector of at least one of the ferromagnetic layers to rotate from the initial state through the property of magnetostriction and thereby changing the resistance to a tunneling current produced by the applied voltage that flows in a direction orthogonal to a plane of the plurality of layers.

2. A method according to claim 1 wherein the initial state of the magnetization vectors that results in their being stable is one of parallel and antiparallel.

3. A method according to claim 1 wherein the initial state of the magnetization vectors that results in their being stable is parallel.

4. A method according to claim 1 wherein the sensing device includes a plurality of sensors that are formed in a two dimensional array and operate as the one sensor such that each sensor detects the pressure of an area associated with that sensor.

5. A method according to claim 1 further comprising the step of sensing an initial resistance of the device when the magnetizations of the ferromagnetic layers are in the initial state without the application of pressure.

6. A method according to claim 5 further comprising the step of determining the pressure applied to the sensing device, the step of determining using both the initial resistance and the sensed resistance in order to minimize the influence of external conditions on the determined pressure.

7. A method according to claim 6 wherein an external condition is liquid film applied over the device.

8. A method according to claim 6 wherein the sensing device includes a plurality of sensors that are each formed and operate as the one sensor such that each sensor detects the pressure of an area associated with that sensor.

9. A method according to claim 1 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, the sign of magnetostriction in the ferromagnetic free layer being such that only compressive forces are sensed in the step of sensing

10. A method according to claim 1 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, the sign of the magnetostriction in the ferromagnetic free layer is such that only tensile forces are sensed in the step of sensing

11. A method according to claim 1 wherein at least one of the ferromagnetic layers is comprised of a multilayer stack that includes a nonmagnetic spacer.

12. A method according to claim 11 wherein the nonmagnetic spacer is ruthenium.

13. A method according to claim 11 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, wherein the free layer comprises the multilayer stack, and wherein a net magnetic moment of the free ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack.

14. A method according to claim 11 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, and wherein the pinned layer comprises the multilayer stack.

15. A method according to claim 14 wherein a net magnetic moment of the pinned ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack.

16. A method according to claim 14 wherein the initial state of the magnetization vectors that results in their being stable is parallel.

17. A method according to claim 11 wherein the ferromagnetic layer that comprises the multilayer stack has a net non-zero magnetostriction.

18. A sensor apparatus that is capable of sensing an applied pressure using an externally supplied current comprising:

a sensing device with at least one sensor including a plurality of layers, the plurality of layers comprising a non magnetic insulating barrier layer disposed between two ferromagnetic layers, and at least one of the ferromagnetic layers having non-zero magnetostriction, wherein the applied pressure will cause a change in the magnetization vector of the at least one ferromagnetic layer having non-zero magnetostriction, which can be sensed as a change in resistance to a tunneling current that develops in a direction orthogonal to a plane of the plurality of layers upon the application of the externally supplied voltage also applied in the direction orthogonal to the plane of the layers.

19. An apparatus according to claim 18 wherein the ferromagnetic layers include NiFe, CoFe or Co.

20. An apparatus according to claim 19 wherein the thickness of each ferromagnetic layer is within the range of 0.1 – 50 nm

21. An apparatus according to claim 20 wherein the thickness of the non-magnetic insulating barrier layer is within the range of 0.1 to 10 nm.

22. An apparatus according to claim 18 wherein the sensor further includes a buffer layer disposed below a lower of the two ferromagnetic layers to assist in uniform epitaxial growth of the lower ferromagnetic layer, and increased TMR response.

23. An apparatus according to claim 22 further including a capping layer disposed above an upper of the two ferromagnetic layers to assist in preventing oxidation during subsequent processing of the sensor.

24. Apparatus according to claim 23 where the capping layer is Tantalum.

25. An apparatus according to claim 18 further including a capping layer disposed above an upper of the two ferromagnetic layers to assist in preventing oxidation during subsequent processing of the sensor.

26. Apparatus according to claim 25 where the capping layer is Tantalum.

27. An apparatus according to claim 18 further including an interlayer disposed between at least one of the ferromagnetic layers and the nonmagnetic insulating barrier spacer, the interlayer provided to increase TMR response and reduce interdiffusion.

28. An apparatus according to claim 27 wherein the interlayer is comprised of one of Co and CoFe.

29. An apparatus according to claim 18 further including an interlayer disposed between each ferromagnetic layer and the nonmagnetic insulating spacer, each interlayer provided to increase TMR response and reduce interdiffusion.

30. An apparatus according to claim 29 wherein each interlayer is comprised of one of Co and CoFe.

31. An apparatus according to claim 18 wherein at least one of the ferromagnetic layers is comprised of a multilayer stack in which a plurality of layers in the multi-layer stack are antiferromagnetically coupled to each other.

32. An apparatus according to claim 18 wherein the sensing device includes a plurality of sensors arranged in an array, each sensor being formed and operating as at least one sensor such that each sensor detects the pressure of an area associated with that sensor.

33. An apparatus according to claim 32 wherein each sensor further includes a buffer layer disposed below a lower of the two ferromagnetic layers to assist in uniform epitaxial growth of the lower ferromagnetic layer, and increased TMR response.

34. An apparatus according to claim 33 wherein each sensor further includes a capping layer disposed above an upper of the two ferromagnetic layers to assist in preventing oxidation during subsequent processing of the sensor.

35. An apparatus according to claim 34 wherein each sensor further includes an interlayer disposed between at least one of the ferromagnetic layers and the nonmagnetic insulating spacer, the interlayer provided to increase TMR response and reduce interdiffusion.

36. An apparatus according to claim 34 wherein each sensor further includes an interlayer disposed between each ferromagnetic layer and the nonmagnetic insulating spacer, each interlayer provided to increase TMR response and reduce interdiffusion.

37. An apparatus according to claim 32 wherein at least one of the ferromagnetic layers is comprised of a multilayer stack in which a plurality of layers in the multi-layer stack are antiferromagnetically coupled to each other.

38. An apparatus according to claim 18 further including a protective coating layer disposed above the an upper of the ferromagnetic layers, said protective coating layer having a surface energy that reduces deposits from adhering thereto.

39. An apparatus according to claim 38 wherein the protective coating layer is a carbon based material.

40. An apparatus according to claim 39 wherein the carbon based material is silicon carbide.

41. An apparatus according to claim 18 further including an insulating layer disposed over an upper of the ferromagnetic layers and a conductive layer disposed over the insulating layer such that the conductive layer provides for protection from electrostatic discharge.

42. An apparatus according to claim 18 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, wherein the pinned ferromagnetic layer is pinned by an antiferromagnetic layer.

43. An apparatus according to claim 42 wherein the antiferromagnetic layer is CrMnPd.

44. An apparatus according to claim 42 wherein the sign of magnetostriction in the ferromagnetic free layer being such that only compressive forces are sensed in the step of sensing

45. A method according to claim 42, wherein the sign of the magnetostriction in the ferromagnetic free layer is such that only tensile forces are sensed in the step of sensing

46. An apparatus according to claim 18 wherein at least one of the ferromagnetic layers is comprised of a multilayer stack that includes a nonmagnetic spacer.

47. An apparatus according to claim 46 wherein the nonmagnetic spacer is ruthenium.

48. An apparatus according to claim 46 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, wherein the free layer comprises the multilayer stack, and wherein a net magnetic moment of the free ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack.

49. An apparatus according to claim 46 wherein one of the ferromagnetic layers is a free layer and one of the ferromagnetic layers is a pinned layer, and wherein the pinned layer comprises the multilayer stack.

50. An apparatus according to claim 49 wherein a net magnetic moment of the pinned ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack

51. An apparatus according to claim 46 wherein the ferromagnetic layer that comprises the multilayer stack has a net non-zero magnetostriction.

52. An apparatus according to claim 18 wherein the ferromagnetic layers have non-zero magnetostriction.

53. A method of sensing pressure using an externally supplied voltage in which applied pressure causes a change in the magnetization vectors of ferromagnetic layers within the device and a corresponding change in resistance comprising the steps of:

providing a sensing device with a sensor including plurality of layers, the plurality of layers comprising a non magnetic insulating layer disposed between the free ferromagnetic layer and a pinned ferromagnetic layer, and an anti-ferromagnetic layer disposed over the pinned ferromagnetic layer, the non magnetic insulating layer providing ferromagnetic coupling of the free and the pinned ferromagnetic layers in an initial state such that magnetization vectors of the free and pinned ferromagnetic layers are substantially parallel to each other; and

sensing the resistance in the plurality of layers upon application of pressure while the externally supplied voltage is being applied in a direction orthogonal to a plane of the layers, the

applied pressure causing the magnetization vector of the free ferromagnetic layer to change from the initial state, and thereby result in a change in resistance to a tunneling current produced by the applied voltage and that flows orthogonal to the plane of the plurality of layers.

54. A method according to claim 53 wherein the sensing device includes a plurality of sensors that are formed in a two dimensional array and operate as the one sensor such that each sensor detects the pressure of an area associated with that sensor.

55. A method according to claim 53 wherein the sensing device includes a plurality of sensors that are formed in a two dimensional array and operate as the one sensor such that each sensor detects the pressure of an area associated with that sensor.

56. A method according to claim 53 further comprising the step of sensing a reference resistance of the device when the ferromagnetic layers are in the initial state without the application of pressure.

57. A method according to claim 56 wherein the step of sensing the reference resistance is sensed either immediately prior to or immediately following the sensing of applied pressure.

58. A method according to claim 56 further comprising the step of determining the pressure applied to the sensing device, the step of determining using both the reference resistance and the sensed resistance in order to minimize the influence of external conditions on the determined pressure.

59. A method according to claim 58 wherein an external condition is a liquid film applied over the device.

60. A method according to claim 58 wherein the sensing device includes a plurality of sensors that are each formed and operate as the one sensor such that each sensor detects the pressure of an area associated with that sensor.

61. A method according to claim 60 wherein the method senses pressure applied during the obtaining of a fingerprint and further includes the step of using the resistance sensed by each sensor to determine the fingerprint.

62. A method according to claim 53 wherein compressive forces are sensed in the step of sensing.

63. A method according to claim 53 wherein tensile forces are sensed in the step of sensing.

64. A method according to claim 53 wherein both of the ferromagnetic layers have non-zero magnetostriction.

65. An apparatus for sensing applied pressure upon application of an externally supplied voltage comprising:

a sensor including:

an antiferromagnetic pinning layer;

a pinned ferromagnetic layer that is pinned by the antiferromagnetic layer;

a free ferromagnetic layer with non-zero magnetostriction; and

a non magnetic insulating barrier layer disposed between the free and pinned ferromagnetic layers, wherein, in an initial state, a net magnetization vector of each of the free and pinned ferromagnetic layers are stable with respect to each other, and wherein applied pressure causes a change in the magnetization vector of one the free ferromagnetic layer through the property of magnetostriction and a corresponding change in resistance, such that the resistance can then be sensed by application of the externally supplied voltage in a direction orthogonal to the plane of the plurality of the layers.

66. An apparatus according to claim 65 wherein, in the initial state, the net magnetization vector of each of the free and pinned ferromagnetic layers are parallel.

67. An apparatus according to claim 65 further including a plurality of sensors, each that are formed in a two dimensional array and operate as the sensor such that each sensor detects the pressure of an area associated with that sensor.

68. An apparatus according to claim 65 wherein the fixed and pinned ferromagnetic layers are comprised substantially of NiFe or CoFe or Co, either alone or in combination.

69. An apparatus according to claim 65 wherein the thickness of each ferromagnetic layer is within the range of 0.5 – 50 nm .

70. An apparatus according to claim 69 wherein the thickness of the non-magnetic insulating layer is within the range of 0.1 to 10 nm.

71. An apparatus according to claim 65 wherein the sensor further includes a buffer layer disposed below a lower one of the pinned and fixed ferromagnetic layers to assist in uniform epitaxial growth of the first ferromagnetic layer, and increased TMR response.

72. An apparatus according to claim 71 further including a capping layer disposed above the second ferromagnetic layer.

73. An apparatus according to claim 65 further including a capping layer disposed above an upper one of the pinned and fixed ferromagnetic layers.

74. An apparatus according to claim 65 further including an interlayer disposed between at least one of the pinned and fixed ferromagnetic layers and the nonmagnetic conducting spacer, the interlayer provided to increase TMR response and reduce interdiffusion.

75. An apparatus according to claim 74 wherein the interlayer is comprised of one of Co and CoFe.

76. An apparatus according to claim 65 further including an interlayer disposed between each of the pinned and fixed ferromagnetic layers and the nonmagnetic insulating spacer, each interlayer provided to increase TMR response and reduce interdiffusion.

77. An apparatus according to claim 76 wherein each interlayer is comprised of one of Co and CoFe.

78. An apparatus according to claim 65 wherein one or both of the pinned and fixed ferromagnetic layers is a laminate of a plurality of layers that form a multilayer stack and are antiferromagnetically coupled to each other.

79. An apparatus according to claim 78 wherein the free layer comprises the multilayer stack, and wherein a net magnetic moment of the free ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack.

80. An apparatus according to claim 78 wherein a net magnetic moment of the pinned ferromagnetic layer is allowed to take on non-zero and zero values for the purpose of controlling a demagnetizing field of the multilayer stack

81. A method according to claim 78 wherein the ferromagnetic layer that comprises the multilayer stack has a net non-zero magnetostriction.

82. An apparatus according to claim 65 further including a protective coating layer disposed above an upper of the pinned and fixed ferromagnetic layers, said protective coating layer having a surface energy that reduces deposits from adhering thereto.

83. An apparatus according to claim 82 wherein the protective coating layer is a carbon based material.

84. An apparatus according to claim 83 wherein the carbon based material is silicon carbide.

85. An apparatus according to claim 65 further including an insulating layer disposed over the upper of the pinned and fixed ferromagnetic layers and a conductive layer disposed over the insulating layer such that the conductive layer provides for protection from electrostatic discharge.

86. An apparatus for sensing pressure comprising:

a substrate;

a sensor formed on the substrate, the sensor including:

a support structure that is smaller than the substrate, thereby providing a cavity; and

a tunneling magnetoresistive sensor formed over the support structure.

87. An apparatus according to claim 86 wherein the tunneling magnetoresistive sensor comprises at least two ferromagnetic layers having a non-magnetic insulating layer disposed therebetween.

88. An apparatus according to claim 87 wherein at least one of the ferromagnetic layers is comprised of a multilayer stack in which a plurality of layers in the multi-layer stack are antiferromagnetically coupled to each other.

89. An apparatus according to claim 87 further including an antiferromagnetic layer, such that one of the ferromagnetic layers becomes pinned by the antiferromagnetic layer, and the other ferromagnetic layer is not pinned by the antiferromagnetic layer.

90. An apparatus according to claim 87 wherein the support structure is a deformable beam.

91. An apparatus according to claim 86 wherein the support structure is a deformable beam.

92. An apparatus according to claim 91 wherein the deformable beam is formed of semiconductor layers.

93. An apparatus according to claim 91 wherein the deformable beam is formed of a conductor.

94. An apparatus according to claim 91 wherein the deformable beam is formed of a dielectric material such as SiO2.

95. An apparatus according to claim 91 wherein the deformable beam has a length of between 2 microns to several hundred microns.

96. An apparatus according to claim 95 wherein the deformable beam has a thickness ranging from 0.1 micron to 20 microns.

97. An apparatus according to claim 96 wherein the width of the beam ranges from 1 microns to several microns

98. An apparatus according to claim 86 wherein the support structure is a membrane.

99. An apparatus according to claim 86 wherein the sensor has a length of 1 to several hundred microns.

100. An apparatus according to claim 86 further including a plurality of the sensors arranged in an array.